WOLF CREEK WATERSHED INVESTIGATION REPORT

APPALACHIAN WATER RESOURCE SURVEY

Athens, Morgan, and Washington Counties
Ohio

September 1967

UNITED STATES DEPARTMENT OF AGRICULTURE

Economic Research Service, Forest Service Soil Conservation Service

FOREWORD

This investigation and report was made under authority of Section 206 of the Appalachian Regional Development Act of 1965. The work was a joint effort of the Economic Research Service, Forest Service, and Soil Conservation Service of the U. S. Department of Agriculture.

The Wolf Creek Watershed was selected because of known water and land resource problems preventing or hindering the economic growth and development of the area. The study investigated solutions to these problems and means for full potential development of water and land resources. Selection of this watershed was discussed and approved by the participating agencies in the Appalachian Water Resource Survey and the Ohio Department of Natural Resources.

In accordance with the Plan of Survey for Development of Water Resources in Appalachia, this report will be reviewed and commented on by agencies in the U. S. Department of Interior; Office of Appalachian Studies, U. S. Army Corps of Engineers; U. S. Department of Health, Education and Welfare; and the Ohio Department of Natural Resources. This review procedure will help insure the coordinated and orderly conservation, development, use, and management of water and land resources.

CONTENTS

THE WATERSHED IN BRIEF

Wolf Creek is located in southeastern Ohio - 70 miles from Columbus, Ohio. The watershed is strictly rural with no towns or large villages. There are four villages in the watershed, the largest of which is Chesterhill with a population of about 400. Larger urban areas, Malta, McConnelsville, and Marietta, are located just outside the watershed.

Wolf Creek has two main branches which join about 1½ miles south of the outlet into the Muskingum River. This confluence is just north of Beverly and Waterford, about 14 miles northwest of the Muskingum River outlet into the Ohio River at Marietta. West Branch of Wolf Creek rises in the western part of Morgan County (northwest of McConnelsville) and flows generally southeast into the northwest corner of Washington County; thence it flows northeast to the junction with South Branch. South Branch of Wolf Creek originates directly west of Marietta and flows generally north to its junction with West Branch. From this junction Wolf Creek flows generally north into the Muskingum River. Elevations range from 630 feet at the outlet to 1,150 feet along the northwestern boundary of the watershed.

Wolf Creek Watershed is about 38 miles long and averages about 6 miles wide, with a total of about 147,780 acres, or almost 231 square miles. It consists of about 81,280 acres in Washington County, 63,900 acres in Morgan County, and 2,510 acres in Athens County.

No major highways or railroads bisect the watershed. U. S. Route 50A, from Marietta to Athens, run generally east and west across the headwaters in the extreme southern edge of the watershed. There are six state routes that cross the watershed. State Route 76, probably the most used state route, generally follows South Branch and South Fork from Waterford to Barlow.

The watershed lies in the East and Central General Farming and Forest Land Resource Region and the Central Allegheny Plateau Land Resource Area.

Soils in the watershed have developed in a wide variety of material including bedrock residuum. Deposits of glacial outwash occur along the Muskingum River at Waterford near the mouth of Wolf Creek.

An estimated 75 to 80 percent of the soils are upland residual soils developed in varying mixtures of acid and calcareous clay shales, limestones, sandstones, and siltstones. Most of the upland soils are on steep hillsides with slopes ranging from 20 over 50 percent. Most hillside slopes are cut by deep drainageways and are often broken by one or more benches having slopes of about 10 to 25 percent. Most soils on the steep hillsides have heavy textures subsoils and are very erosive if not protected. Landslips are common, giving irregular topography in many places.

Hillside slopes in the Watertown-Warren-Barlow Township area are dominated by the reddish, clayey Upshur soils. A soil complex, consisting of varying amounts of Upshur, Gilpin, and Summitville soils is dominant. This soil complex is extensive throughout the watershed.

Limestone-influenced soils are extensive in the Morgan County part of watershed. Principal soils there are the heavy-textured Guernsey and Brooke soils, with smaller amounts of the more silty Westmore soils.

The acid, moderately-coarse textured Dekalb and Ramsey soils developed from sandstone are important in the Wesley Township area of Washington County. Many slopes in this area are stony or rocky with vertical sandstone cliffs 10 to 50 feet high.

Upshur and Gilpin soils are dominant on the narrower ridgetops. The deeper Woodsfield, Zanesville, and Wellston soils are on most of the wider ridgetops. Guernsey, Brooke, Westmore, Coolville, Rarden, Keene, Dekalb, Ramsey, and Clymer soils also occur on ridgetops but are of minor extent.

Deep colluvial soils occupy the lower footslopes and wider benches of most every hillside. The reddish, fine-textured Vandalia soils are most extensive and occur below slopes dominated by Upshur soils. The brownish, fine textured Brookside and the dark colored Sees and Woolper soils are important below hillsides dominated by limestone soils. The acid, yellowish, loamy Shelocte and Laidig soils occur below most areas of Dekalb, Ramsey, and Gilpin soils.

Areas of Monongahela and Vincent soils occur in nearly all parts of the watershed. They occupy high level, old stream terraces 50 to 300 feet above present drainage. These old terrace levels are most prominent in the Barlow-Watertown-Palmer Township area of Washington County. Markland soils are also important, but occur mainly on lower level terraces. It is estimated that terrace soils occupy about 10 percent of the watershed.

Soils on the bottomlands are mostly well to moderately well drained, and medium acid to neutral. They are very productive, but subject to flooding. Chagrin, Lindside, and Moshannon soils are the most extensive. The somewhat poorly drained Newark and Melvin soils are of minor extent and occur mainly along the West Branch and its tributaries. The shallow to moderately deep Hartshorn soils occur along most of the narrow bottomlands along the smaller streams.

Present land use in the watershed is approximately as follows: 20 percent cropland, 32 percent pasture, 33 percent woodland, and 15 percent other uses. By 1980, land use is expected to have changed to approximately the following: 15 percent cropland, 30 percent pasture, 40 percent woodland, and 15 percent other uses.

The State of Ohio owns 3,100 acres of land in the Wolf Creek Wildlife Area. This area, with its farm ponds, improved vegetative program, and managed hunting, has been utilized by many sportsmen. The influx of hunters and fishermen has added to income of business establishments in nearby communities. This added revenue has stimulated local people to express a desire for further improvement and expansion of fish and wildlife recreation facilities.

About 48,766 acres of the watershed are in forest land which is scattered uniformly throughout the area.

Most of the forest land is privately-owneed. About 7 percent (9,800 acres) of the watershed is within Wayne National Forest purchase boundary, but none of the land is in federal ownership.

The forest land is predominantly hardwood. Principal types are oak-hickory, mixed hardwoods, and black ash-elm-red maple. Associated species are red, white, black and chestnut oak, hickory, elm, ash, red and sugar maple, yellow poplar, beech, and sycamore.

There are good markets for sawlogs but only limited markets for smaller forest products.

According to the U. S. Census of Agriculture, the average size farm in 1964 was about 150 acres, which was 7 percent larger than five years previously. Value of land and buildings for the average farm in 1964 was about $15,500, or $103 per acre. This represents an increase of about 8 percent in value of land and buildings per farm since 1959. Value of all farm products sold averaged only $2,860 in 1964, but was 12 percent higher than farm sales in 1959. About 75 percent of these sales are livestock and livestock products. About half of the farm operators work off the farm 100 days or more per year.

WATERSHED PROBLEMS AND NEEDS

Floodwater Damages

Annual floodwater damage to crops and pasture is estimated to be $32,100. Other agricultural floodwater damage is estimated at $4,000 annually. Approximately 3,300 acres of flood plain are subject to flooding by a 100-year flood. Land use in the flood plain consists of: cropland, 50 percent; pasture, 25 percent; woodland, 10 percent; and other, 15 percent.

Annual damages to roads and bridges is about $5,900. Indirect damages include 10 percent of agricultural damages and 15 percent of transportation damages. TABLE 1 lists the estimated average annual damages.

Erosion and Sediment

Erosion of upland cropland and pasture is moderate. Water-borne sediment contributes to some crop and pasture damage on the flood plain.

The forest land is generally in a poor hydrologic condition, either because it was formerly cleared land which has reverted to trees, or it has been abused through lack of proper management. This condition contributes to excessive runoff resulting in erosion, sediment production, and an increase in frequency of flooding. Since 33 percent of the watershed is forest land, improvement of the hydrologic condition is a major watershed need.

Agricultural Water Management

Part of the flood plain consists of soils that need tile and/or surface drainage for optimum crop and pasture production. Generally, existing channels provide adequate clearance for tile outlets. Reduction of flooding would make additional drainage economically feasible.

There is no apparent need for irrigation water. Water for livestock and general farm use can be provided through present programs.

Non-Agricultural Water Management

The Federal Water Pollution Control Administration reports there are no known water quality problems in the watershed.

The Wolf Creek Steering Committee has expressed concern for the need of surface water storage to provide municipal water supplies for Pennsville, Todds, Chesterhill, and some of the villages in the southern part of the watershed. This steering committee has been joined in its expression of needs for water-based recreational facilities within the area by the Marietta City Council. One of the project objectives, listed in the PL-566 Watershed Protection and Flood Prevention Application, is for the development of recreation and fish and wildlife facilities.

Population projections for Appalachian Sub-Region 8, listed in this report, support these needs, i.e. an increase of 138 percent by 2020.

TABLE I

ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE

WOLF CREEK WATERSHED, OHIO RIVER BASIN

(Dollars) 1/

ITEM	DAMAGES
Crop and Pasture	32,100
Transportation	5,900
Other Agriculture	4,000
Subtotal	42,000
Indirect	4,500
Total Damage	46,500

1/ Price Base - Adjusted Normalized.

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PHYSICAL POTENTIAL FOR MEETING NEEDS

The area has an average annual rainfall of 41 inches which yields about 14 inches of annual runoff. This rainfall and runoff, if properly managed, should be sufficient for the foreseeable future needs.

There are potential reservoir sites throughout the watershed. Installation of the more economical sites located upstream from the major damage areas could do much toward reducing floodwater damage. If additional reduction in flooding is desired, channel modification could be employed. Installation of the reservoirs could also provide the necessary impoundments to help meet the recreational and municipal water supply needs. Storage could be available for water quality management and other beneficial uses either in or outside the watershed.

The forest land has a high to medium potential to improve hydrologically. This potential can be realized with proper protection and management.

LOCAL INTEREST IN PROJECT DEVELOPMENT

This watershed is in three soil and water conservation districts - 55 percent in Washington, 43 percent in Morgan, and 2 percent in Athens.

Local people have prepared an application for a PL-566 Watershed Protection and Flood Prevention Project. The application was signed by the supervisors of all three soil and water conservation districts, and by the Boards of County Commissioners in all three counties. The proposed project has the endorsement of local farm organizations, county agricultural extension agents, township trustees, school teachers and administrators, sportsman organizations, and county and state highway departments.

There is an active steering committee at work. The Marietta City Council has endorsed the project and the activity of the steering committee.

The Ohio Department of Natural Resources, after a study of the watershed and review of the PL-566 application, has recommended approval for further study through a preliminary investigation by the Soil Conservation Service.

If a watershed protection and flood prevention project is initiated, a legal entity, consistent with the laws of the State of Ohio, would meet the needs for project action.

There are 1,800 farms entirely or partially within the watershed. Total number of soil and water conservation district cooperators is 473. This represents 26 percent participation.

WORKS OF IMPROVEMENT FOR POTENTIAL DEVELOPMENT

Land Treatment Measures

Most of the upland cropland, above the terraces, needs contour strip cropping. Diversion channels are needed to protect bottom land from upland runoff. Grassed waterways are needed to dispose of excess upland water without erosion damage. Tile and/or surface drainage is needed on one-fourth of the flood plain soils.

About 70 percent of the permanent pasture needs treatment with lime and fertilizer, as well as seeding or reseeding, to establish the desired cover.

Fire is not a serious problem in the forest land, but continued protection is basic and essential to derive the maximum benefits from all watershed protective measures.

Tree planting is needed to establish an adequate protective cover on some abandoned agricultural lands.

Logging roads and skid trails should be properly located and maintained by erosion control.

Forest land is grazed in some areas of the watershed. Protection of this land from domestic livestock is needed.

Hydrologic stand improvement practices are needed on a large part of the forest land to establish and develop desirable species and to maintain favorable stocking and stand conditions.

Structural Measures

Fifteen potential structure sites were examined. Four were discarded because of their small size, poor location, or unfavorable topography. The remaining 11 sites are suitable for development within one or both of the levels of development discussed herein. Nine sites were selected for development to meet identified needs. The two remaining sites could be developed in addition to the nine to meet potential needs.

Structure Site Nos. 1, 2, 3, 4, 5, 6, 7, 9, and 10 could provide the required floodwater retarding storage to correct the present flooding problems. In addition Structure Site Nos. 4 and 9 could provide the required storage for municipal water supply and a portion of the desired storage for the recreational development. Structure Site No. 3 could also provide additional storage for fish and wildlife development. Small permanent conservation pools at Structure Site Nos. 1, 2, 5, 6, 7, and 10 have a potential for added fishery habitat. The fishery habitat at Structure No. 2 is particularly important due to its partial location within the Wolf Creek wildlife area.

Structure Site No. 3, located largely within Wolf Creek wildlife area, appears suited for fish and wildlife development. Several county roads could provide hunters and fishermen good access into the area. The 160-acre permanent pool could create a demand for recreational facilities.

Local interest for multiple-purpose development (flood prevention, municipal water supply, and recreation) at Structure Site No. 4 appears to be high. The Wolf Creek Watershed Steering Committee reports that the general public favors an impoundment to be used for the purpose of flood prevention, recreation, and municipal water supply for the Pennsville-Chesterhill area. Ridges on the left side of the 230-acres lake could be developed into a day camp and those on the east side into summer leisure or cluster homes.

The Steering Committee also proposed the construction of Structure Site No. 9 as a multiple-purpose flood prevention, recreational and municipal water supply impoundment for day use. Day use of the 1,060-acre lake from the urbanized market of the Belpre-Marietta-Parkersburg area could be high. This urban area is located just outside the watershed, but would be only about 10 miles from the lake. Interstate Highway No. 77, which passes through the urban area could funnel a large number of vacationers from more distant areas into this recreation complex. Fish and wildlife habitat of the area could be greatly improved by stocking this lake with fish and by enhancement of the wildlife environment. In addition to access roads and parking facilities, other basic facilities would include construction of camp sites, boat docks and ramps, beaches, trails, picnic areas, and sanitary facilities. Private capital could be expended on the surrounding lands for lodges, summer cabins, and permanent homes.

The level of development designated as maximum potential within this report includes the above mentioned sites as well as Structure Site Nos. 8 and 11. These two sites have a fair potential for water impoundment. Since they did not appear to be of value in floodwater retardation, or for any other identified need, they were excluded from the previous discussion. The maximum development for the multiple-purpose structure Site Nos. 3, 4, and 9 is the same as the level of development to meet the identified needs. Storage is limited at Structure Site Nos. 2 and 7 to that required for temporary floodwater storage due to development within the flood plain. Structure Site Nos. 1, 5, 6, and 10, could be developed into multiple purpose reservoirs. The storage in excess of that needed for flood control would be used for municipal water supply, recreation, water management control, or other beneficial use.

Population protections for Appalachian Economic Sib-Region 8 which embraces this watershed show increases as follows: to 1980 -

35 percent; to 2000 - 84 percent; and to 2020 - 138 percent. It is estimated that these increases would be reasonable for this watershed. Installation of a project, such as outlined in this report, could prove the above projection estimates to be conservative.

The information given below was computed from yield data curves based on study and analysis of runoff data on Wakatomika Creek near Frazeysburg, Ohio. This information supports the municipal and beneficial storage needs shown in this report.

Str. Site No.	Purpose	Percent Chance* of Shortage	Additional Supply Provided (Year 2020)		
			Location	cfs	MGD
4	Water Supply	1	Str. Outlet	1.1	.73
9	Water Supply	1	Str. Outlet	1.9	1.25
1,5,6,8,10,11	Add. Supply	10	W.S. Outlet	58	38

* Usually used in the Northeast.

TABLE II

STRUCTURE DATA

WOLF CREEK WATERSHED, OHIO RIVER BASIN

Site No.	Drainage Area	Est. Height of Dam	Est. Vol. of Fill	PRINCIPAL SPILLWAY Type	Release Rate	EMERGENCY SPILLWAY Type	% Chance of Use	Max. Surface Area Em. Spill. Level
	(Sq.Mi.)	(Feet)	(Cu.Yd.)		(CSM)			(Acres)
1	5.2	38 (53)	45,000 (120,000)	Reinforced Concrete Conduit	12	Veg.	1	90 (170)
2	24.3	40 (40)	94,000 (94,000)	" " "	16	Veg.	1	370 (370)
3	7.2	60 (60)	250,000 (250,000)	" " "	12	Veg.	1	190 (190)
4	9.5	57 (57)	170,000 (170,000)	" " "	12	Veg.	1	280 (280)
5	9.2	52 (74)	87,000 (170,000)	" " "	12	Veg.	1	100 (215)
6	10.9	49 (71)	130,000 (250,000)	" " "	12	Veg.	1	125 (255)
7	21.6	41 (41)	76,000 (76,000)	" " "	14	Veg.	1	215 (215)
8	6.8	- (55)	- (120,000)	" " "	12	Veg.	2	- (170)
9	39.8	54 (54)	95,000 (95,000)	" " "	12	Veg.	1	1,250 (1,250)
10	11.0	44 (61)	58,000 (140,000)	" " "	12	Veg.	1	160 (385)
11	7.0	- (58)	- (120,000)	" " "	12	Veg.	2	- (220)
TOTAL	152.5		1,005,000 (1,605,000)					2,780 (3,720)

NOTE: Figures not in parentheses indicate the development of the site for identified needs.
Figures enclosed in parentheses reflect the development of the site to its full potential.

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TABLE III

RESERVOIR STORAGE CAPACITY

WOLF CREEK WATERSHED, OHIO RIVER BASIN

Site No.	Drainage Area	STORAGE CAPACITY EVALUATED												Additional Storage Capac. Available
		FLOOD PREVENTION												
		Sediment		Detention		Subtotal		Recreation		Municipal Water Supply		Total		
	(Sq.Mi.)	(Ac.Ft.)	(In.)	(Ac.Ft.)	(In.)	(Ac.Ft.)	(In.)	(Ac.Ft.)	(In.)	(Ac.Ft.)	(In.)	(Ac.Ft.)	(In.)	(Ac.Ft.)
1	5.2	345	1.2	665	2.4	1,010	3.6	-	-	-	-	1,010	3.6	1,940
2	24.3	1,620	1.2	2,590	2.0	4,210	3.2	-	-	-	-	4,210	3.2	-
3	7.2	575	1.5	885	2.3	1,460	3.8	2,685 1/	7.0			4,145	10.8	-
4	9.5	760	1.5	1,160	2.3	1,920	3.8	3,040 2/	6.0	500	1.0	5,460	10.8	-
5	9.2	615	1.2	1,130	2.3	1,745	3.5	-	-	-	-	1,745	3.5	3,440
6	10.9	725	1.2	1,390	2.4	2,115	3.6	-	-	-	-	2,115	3.6	4,075
7	21.6	1,440	1.2	2,300	2.0	3,740	3.2	-	-	-	-	3,740	3.2	-
8	6.8	545	1.5	725	2.0	1,270	3.5	-	-	-	-	1,270	3.5	2,540
9	39.8	3,180	1.5	4,880	2.3	8,060	3.8	14,240 3/	7.0	600	-	22,900	10.8	-
10	11.0	880	1.5	1,410	2.4	2,290	3.9	-	-	-	-	2,290	3.9	4,100
11	7.0	560	1.5	750	2.0	1,310	3.5	-	-	-	-	1,310	3.5	2,620
TOTAL	152.5	11,245		17,885		29,130		19,965		1,100		50,195		18,715

1/ Surface Area of Recreation Pool = 160 acres.

2/ " " " " = 230 acres.

3/ " " " " = 1,060 acres.

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NATURE AND ESTIMATE OF COSTS OF IMPROVEMENT

The basis for estimating the costs of potential structural improvements was 7½-minute USGS Quadrangle Sheets from which stage-storage curves were developed. Crest of each emergency spillway was placed so as to be used on an average of once in 100 years. This elevation was obtained by an approximate routing method using curves relating the volume retarded to the total volume of inflow for a given storm type and average release rate. By imposing the restrictions that the conduit must be 24 inches or greater in diameter, and that 80 percent of the retarded water discharged in 10 days after reaching its crest, average release rates were determined. Design and freeboard elevations were determined by a modification of the rapid routing procedure developed by the SCS Regional Technical Service Center at Upper Darby, Pennsylvania. Estimated cost of each potential structure was based on a unit cost per cubic yard of earthfill taken from the 1966 unit cost curve. The curve was plotted from the total bids of actual contracts awarded for watershed structures in a similar land resource area.

Installation service cost was in accordance with cost records from the Soil Conservation Service files for similar structures built in the past five years.

Easement costs were based on local property values and from observations in the field and from elevations based on the USGS Quadrangle sheets. For the level of development to meet identified needs, $563,000 were included for land easements and $200,000 for buildings.

Operation and maintenance costs for nine structures were estimated to be $2,870 annually.

Cost of administering contracts was taken to be 3 percent of construction costs.

Amounts of $100,000, and $100,000, and $1,000,000 were included for basic facility construction at Structure Site Nos. 3, 4, and 9, respectively. Additional land acquisition was placed at $20,000, $50,000, and $200,000, respectively, for camp, picnic, and other recreational users. Operation and maintence estimates for recreational facilities included respective amounts of $15,000, $10,000, and $50,000.

TABLE IV

ESTIMATED STRUCTURAL COST

WOLF CREEK WATERSHED, OHIO RIVER BASIN

(Level of Development to Meet Identified Needs)

Item	Unit	Amount Planned	Estimated Total Cost (Dollars) 1/
STRUCTURAL MEASURES:			
Construction:			
Floodwater Retarding Str.	No.	6	685,000
Multiple Purpose Structures:			
FP, Recreation & Municipal Water Supply	No.	2	1,502,000
FP & Recreation	No.	1	287,000
Subtotal			2,474,000
Installation Services			787,000
Land Easements & R. W.			1,385,000
Administration of Contracts			73,000
TOTAL STRUCTURAL MEASURES		9	4,719,000

1/ Price Base - 1966.

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TABLE V

DISTRIBUTION OF STRUCTURAL COST

WOLF CREEK WATERSHED, OHIO RIVER BASIN

(Level of Development to Meet Identified Needs)

Structural Measures	Str. No.	Installation Cost (Dollars) 1/				
		Construction	Installation Services	Land Easements and R. W.	Admin. of Contracts	Installation Cost
Single Purpose Structures:						
Flood Prevention	1	81,000	27,000	35,000	2,000	145,000
Flood Prevention	2	132,000	44,000	144,000	4,000	324,000
Flood Prevention	5	122,000	40,000	60,000	3,000	225,000
Flood Prevention	6	150,000	50,000	57,000	4,000	261,000
Flood Prevention	7	107,000	36,000	130,000	3,000	276,000
Flood Prevention	10	93,000	30,000	110,000	3,000	236,000
Multiple Purpose Structures:						
F. P. & Recreation	3	250,000	82,000	90,000	7,000	429,000
Basic Facilities		100,000	33,000	20,000	3,000	156,000
F. P. Rec. & M.W.S.	4	187,000	62,000	103,000	6,000	358,000
Basic Facilities		100,000	33,000	50,000	3,000	186,000
F. P. Rec. & M.W.S.	9	152,000	50,000	386,000	5,000	593,000
Basic Facilities		1,000,000	300,000	200,000	30,000	1,530,000
TOTAL		2,474,000	787,000	1,385,000	73,000	4,719,000

1/ Price Base - 1966.

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TABLE V-A

DISTRIBUTION OF STRUCTURAL COST

WOLF CREEK WATERSHED, OHIO RIVER BASIN

(Full Development Potential)

Structural Measurers	Str. No.	Installation Cost (Dollars) 1/				
		Construction	Installation Services	Land Easements and R. W.	Admin. of Contracts	Installation Cost
Single Purpose Structures:						
Flood Prevention	2	132,000	44,000	144,000	4,000	324,000
Flood Prevention	7	107,000	36,000	130,000	3,000	276,000
Beneficial Storage	8	144,000	48,000	59,000	4,000	235,000
Beneficial Storage	11	144,000	48,000	155,000	4,000	351,000
Multiple Purpose Structures:						
F. P. & Beneficial	1	156,000	52,000	77,000	4,000	289,000
F. P. & Recreation		250,000	82,000	90,000	7,000	429,000
Basic Facilities	3	100,000	33,000	20,000	3,000	156,000
F. P. & Recreation		187,000	62,000	103,000	6,000	358,000
Basic Facilities	4	100,000	33,000	50,000	3,000	186,000
F. P. & Beneficial	5	187,000	62,000	108,000	6,000	363,000
F. P. & Beneficial	6	260,000	86,000	96,000	8,000	450,000
F. P. & Recreation		152,000	50,000	386,000	5,000	593,000
Basic Facilities	9	1,000,000	300,000	200,000	30,000	1,530,000
F. P. & Beneficial	10	161,000	53,000	172,000	5,000	391,000
TOTAL		3,080,000	989,000	1,790,000	92,000	5,951,000

1/ Price Base - 1966.

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TABLE VI

COST ALLOCATION

WOLF CREEK WATERSHED, OHIO RIVER BASIN

(Level of Development to Meet Identified Needs)

(Dollars) 1/

Item	Flood Prevention	Recreation	Municipal Water Supply	Total
Single Purpose:				
Structure No. 1	145,000	-	-	145,000
Structure No. 2	324,000	-	-	324,000
Structure No. 5	225,000	-	-	225,000
Structure No. 6	261,000	-	-	261,000
Structure No. 7	276,000	-	-	276,000
Structure No. 10	236,000	-	-	236,000
Multiple Purpose:				
Structure No. 3	107,000	322,000	-	429,000
Basic Facilities		156,000	-	156,000
Structure No. 4	90,000	229,000	39,000	358,000
Basic Facilities		186,000	-	186,000
Structure No. 9	146,000	429,000	18,000	593,000
Basic Facilities		1,530,000	-	1,530,000
TOTAL	1,810,000	2,852,000	57,000	4,719,000

1/ Price Base - 1966.

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TABLE VI-A

COST ALLOCATION

WOLF CREEK WATERSHED, OHIO RIVER BASIN

(Full Development Potential)

(Dollars) 1/

Item		Flood Prevention	Recrea-tion	Municipal Water Supply	Additional Beneficial Storage Available	Total
Single Purpose:						
Flood Prevention	#2	324,000	-		-	324,000
Flood Prevention	#7	276,000	-		-	276,000
Beneficial Storage	#8	-	-		255,000	255,000
Beneficial Storage	#11	-	-		351,000	351,000
Multiple Purpose:						
F.P. & Beneficial	#1	72,000	-	-	217,000	289,000
F.P. & Recreation	#3	107,000	322,000	-	-	429,000
Basic Facilities		-	156,000	-	-	156,000
F.P. & Recreation	#4	90,000	229,000	39,000	-	358,000
Basic Facilities		-	186,000	-	--	186,000
F.P. & Beneficial	#5	91,000	-	-	272,000	363,000
F.P. & Beneficial	#6	113,000	-	-	337,000	450,000
F.P. & Recreation	#9	146,000	429,000	18,000	-	593,000
Basic Facilities		-	1,530,000	-	-	1,530,000
F.P. & Beneficial	#10	98,000	-	-	293,000	391,00
TOTAL		1,317,000	2,852,000	57,000	1,725,000	5,951,000

1/ Price Base - 1966.

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EFFECTS AND ECONOMIC FEASIBILITY OF POTENTIAL DEVELOPMENT

Water Resource Development

Average annual flood reduction benefits were estimated to be $26,300 from structural measures and $1,400 from land treatment. Land enhancement to agriculture, including more intensive use and some changed land use, was estimated to provide benefits of $7,800.

Minimum basic facilities for recreation were figured for Structure Site Nos. 3 and 4. Average annual use was estimated at 32,000 and 34,500 visitor-days, respectively, for these two sites. Benefit rates of $1.00 and 75 cents per visitor-day, respectively, were assigned. After discounting, the respective average annual benefits could be $30,000 and $24,300. For Structure Site No. 9, costs were estimated on the basis of a highly-developed recreational facility. Average annual use was estimated at 238,000 with a benefit rate of $1.25 per visitor-day assigned. After discounting, the average annual benefit could be $279,600.

The development of additional water storage facilities will increase recreational use of the surrounding forest land. This could have an impact on the management and protection of the area.

Municipal water supply benefits from Structure Site Nos. 4 and 9 were estimated to be $1,900 annually. This is based on the assumption that a 1:1 ratio would be used between annual costs and annual benefits.

Direct redevelopment benefits were used in the evaluation and were estimated at $63,200. This includes 30 percent of construction costs and 50 percent of operation and maintenance cost (both are on an annual equivalent basis).

Local secondary benefits would be $43,200 annually.

The ratio of average annual benefits to average annual cost, for all works of improvement, would be 2:1. The benefit-cost ratio, excluding local secondary benefits, would be 1.9:1.

Summary of benefits, costs, and comparisons are listed in the attached TABLES VII and VIII.

With the level of development to meet the identified needs, most of the land in the agricultural reach Nos. 1, 2, 4, 4a, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, and 16, has between a two and three-year growing season level of protection. The remaining reaches were not evaluated since the agricultural land is quite limited in those areas.

For existing conditions, the 2-year flood would inundate 1,300 acres and the 100-year flood would cover 3,280 acres in the agricultural reaches listed above. With the level of development described in this report, the acreage flooded would be 530 and 2,250, respectively, for the 2-year and 100-year floods.

Total Area Development

The proposed land treatment and structural measures could provide a 3 to 5 year flood protection to the flood plain. The level of protection provided is not sufficient for industrial or commercial development.

Average annual flood prevention benefits are estimated to be $26,300. Land enhancement benefits from more intensive land use and changed land use amount to $7,800. The water resource development could provide 1,450 surface acres for recreation and basic facilities for 304,500 visitor-days annually. The recreational facilities will help meet the projected need in the area. Recreational benefits amount to $333,900 with additional regional expansion benefits of $226,500 from the increased business activity created by the money spent within the area by people from outside the area.

The potential development could provide 1,100 acre-feet of storage for municipal water supply for the communities in the watershed. The benefits to water supply amounts to $1,900. The water supply should meet the projected need of the watershed.

Redevelopment benefits are estimated to be $58,200 and reflect the wages and salaries of unemployed and underemployed people used in construction, operation, and maintenance of the water resource development. Regional expansion benefits for agricultural enhancement from changed land use and more intensive land use amount to $12,900 annually.

Average annual benefits and costs for the total area development amount to $441,000 and $232,500, respectively. The benefit-cost ratio is 1.9:1. Summaries of benefits and costs are listed in TABLE VIII-A.

The benefit-cost ratio is based on the total national benefits and total area development costs. This does not include local secodary or regional transfer benefits.

Total regional benefits amount to $719,800 and include user, redevelopment, national expansion, and inter- and intra-regional transfer benefits. There could be additional national benefits if a need arises in the future for the 18,715 acre-feet of beneficial storage.

The methodology used in determining expansion benefits was the USDA evaluation procedures for upstream watershed developed for this study.

TABLE VII

ANNUAL COST

WOLF CREEK WATERSHED, OHIO RIVER BASIN

(Dollars) 1/

Evaluation Unit	Amortization of Installation Cost 2/	Operation and Maintenance Cost	Total
1	154,600	77,900 3/	232,500 4/

1/ Price Base - 1966 for installation costs; adjusted normalized for operations and maintenance and other economic costs.

2/ 3-1/8% - 100 year amortization period.

3/ Includes $75,000 for operation and maintenance of recreational facilities.

4/ Flood prevention cost is $61,320.

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TABLE VIII

COMPARISON OF BENEFITS AND COSTS FOR STRUCTURAL MEASURES

WOLF CREEK WATERSHED, OHIO RIVER BASIN

(Dollars) 1/

Evaluation Unit	AVERAGE ANNUAL BENEFITS							Average Annual Costs	Benefit Cost Ratio
	Flood Prevention								
	Damage Reduction	More Intensive Use (Agr.Lands)	Recre-ation	Municipal Water Supply	Redevel-opment	Local Secondary	Total		
1	26,300	7,800	333,900	1,900	63,200	43,200	476,300	232,500	2:1
TOTAL	26,300 2/	7,800	333,900	1,900	63,200	43,200	476,300	232,500	2:1

1/ Price Base - Adjusted normalized for benefits, operation and maintenance, and other economic costs; 1966 for installation cost.

2/ In addition it is estimated that land treatment measures will provide flood flood damage reduction benefits of $1,400 annually.

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TABLE VIII-A

COMPARISON OF BENEFITS AND COSTS FOR
STRUCTURAL MEASURES INCLUDING
AREA DEVELOPMENT

WOLF CREEK WATERSHED, OHIO RIVER BASIN

(Dollars) 1/

Category and Class of Benefits	National Account Only	Regional Account Only	Both National & Regional Accounts	Total National Benefits	Total Regional Benefits
User Benefits:					
Flood Prevention 2/			26,300	26,300	26,300
Land Enhancement			7,800	7,800	7,800
Recreation			333,900	333,900	333,900
Municipal Water Supply			1,900	1,900	1,900
Subtotal			369,900	369,900	369,900
Redevelopment		52,300	58,200	58,200	110,500
User and Redevelopment		52,300	428,100	428,100	480,400
Expansion Benefits:					
Development		0	0	0	0
Recreation		226,500	0	0	226,500
Agricultural Enhancement			12,900	12,900	12,900
Subtotal		226,500	12,900	12,900	239,400
Total Benefits		278,800	441,000	441,000	719,800

Annual Cost:

Water Resource Plan	235,500
Area Development Plan	0
Total Annual Cost	235,500

1/ Price Base - Adjusted normalized for benefits and O&M; 1966 for installation cost for water resource plan.

2/ In addition, it is estimated that land treatment measures will provide flood damage reduction benefits of $1,400 annually.

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ALTERNATE OR ADDITIONAL POSSIBILITIES

Area above Structure Site No. 2, which is subject to being flooded, may better be protected by means of channel modification. Increased peaks would be of no consequence downstream since they would be reduced in passing through the structure. Structure Site No. 1 could then be deleted and its cost applied toward increasing channel capacities.